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FORCED CONVECTIVE BOUNDARY LAYER FLOW OF A NANOFLUID PAST A CONTINUOUS STRETCHING SURFACE

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To my beloved mother, father, family, lecturers and friends.

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ABSTRACT

Nanofluid is an advanced kind of fluid containing small quantities of nanoparticles that are uniformly and stably suspended in a base liquid. It has a higher thermal conductivity and enhanced heat transfer coefficient than its base fluid. In this study, the steady forced convective boundary layer flow of a nanofluid past a continuous stretching surface with suction or injection and magnetic effect is investigated. This mathematical model describes the flow of nanofluid that incorporates the effects of Brownian motion and thermophoresis. The governing nonlinear partial differential equations are transformed into a system of nonlinear ordinary differential equations using similarity transformation which is then solved numerically using a finite difference scheme known as the Keller-box method. The numerical results obtained show that the value of the reduced Nusselt number decreases with the increasing value of the Brownian motion parameter, *Nb* and thermophoresis parameter, *Nt*. Whereas, the value of the reduced Sherwood number increases with *Nt* but decreases with *Nb*. It is also observed that the reduced Nusselt and Sherwood numbers decrease with an increase of the velocity stretching parameter, *m*, the magnetic parameter, *Mn* and the injection parameter, $d > 0$. The suction parameter, $d < 0$, on the other hand, tends to increase the skin friction coefficient, reduced Nusselt and Sherwood numbers. The results show that the Brownian motion and thermophoresis influence the flow characteristics of nanofluids by either warming the boundary layer or aggravating the collisions between the nanoparticles and molecules of the base fluid.

ABSTRAK

Bendalir nano merupakan sejenis bendalir yang mengandungi sejumlah kecil zarah nano yang terampai secara seragam dan stabil dalam bendalir asasnya. Ia mempunyai konduktiviti terma yang tinggi dan dapat meningkatkan pekali pemindahan haba berbanding bendalir asasnya. Dalam kajian ini, aliran mantap untuk olakan paksaan lapisan sempadan bagi bendalir nano merentasi permukaan regangan yang berterusan dengan kesan sedutan atau suntikan dan juga kesan magnet telah dikaji. Model matematik yang digunakan untuk aliran bendalir nano ini menggabungkan kesan gerakan Brownan dan juga kesan termoforesis. Persamaan terbitan separa tak linear dijelmakan kepada sistem persamaan terbitan biasa tak linear dengan menggunakan penjelmaan keserupaan dan seterusnya diselesaikan secara berangka dengan menggunakan skema beza terhingga yang dikenali sebagai kaedah kotak Keller. Keputusan-keputusan berangka yang diperoleh menunjukkan bahawa nombor Nusselt berkurangan dengan peningkatan parameter gerakan Brownan, *Nb* dan termoforesis, *Nt*. Manakala nombor Sherwood meningkat dengan *Nt* tetapi berkurangan terhadap *Nb*. Pemerhatian juga menunjukkan bahawa nombor Nusselt dan nombor Sherwood berkurangan dengan peningkatan parameter halaju regangan, *m*, parameter magnet, *Mn*, dan parameter suntikan, $d > 0$. Parameter sedutan, $d < 0$ pula meningkatkan pekali geseran kulit, nombor Nusselt dan nombor Sherwood. Keputusan menunjukkan bahawa gerakan Brownan dan termoforesis mempengaruhi ciri-ciri aliran bagi bendalir nano dengan memanaskan lapisan sempadan atau meningkatkan pelanggaran di antara zarah-zarah nano dan bendalir asasnya.